FQ5-473

Claims:

1. A system for inserting additional information in DCT (discrete cosine transform) coefficients by referring to a variable-length code table, wherein the DCT coefficients are generated in blocks from image data, the system comprising:

5   an information inserting section for inserting additional information into input DCT coefficients in a block by changing at least one DCT coefficient of the input DCT coefficients to produce changed DCT coefficients; and

a total code length restoring section for

10   correcting a level of one DCT coefficient selected from the changed DCT coefficients in the block to produce corrected DCT coefficients by referring to the variable-length code table, wherein the one DCT coefficient is selected so that a total code length of codes generated from the corrected DCT coefficients

15   is equal to an original total code length of codes generated from the input DCT coefficients in the block.

2. The system according to claim 1, wherein the total code length restoring section comprises:

a difference calculator for calculating a total

20   code length difference between the original total code length and a total code length of codes generated from the changed DCT coefficients in the block;

a target code length calculator for calculating a target code length for a non-zero DCT coefficient sequentially selected from the changed DCT coefficients based on a difference between the total code length difference and a current code

5 length of the non-zero DCT coefficient; and

a level corrector for correcting a level of the non-zero DCT coefficient to produce corrected DCT coefficients when a corrected code length of a code generated from a combination of a zero-run length and a corrected level of the

10 non-zero DCT coefficient substantially matches the target code length.

3. The system according to claim 2, wherein the level corrector comprises:

a level candidate calculator for calculating a

15 level candidate of the non-zero DCT coefficient based on a current level of the non-zero DCT coefficient;

a determiner for determining whether a corrected code length of a code generated from a combination of a zero-run length and the level candidate of the non-zero DCT coefficient

20 substantially matches the target code length; and

a corrector for correcting a level of the non-zero DCT coefficient to the level candidate when the corrected code length matches the target code length.

4.   The system according to claim 3, wherein the level candidate calculator comprises:

a level range limiter for limiting a level range of the non-zero DCT coefficient based on the current level of
5   the non-zero DCT coefficient; and

a candidate generator for generating a level candidate within the level range.

5.   The system according to claim 2, wherein the level corrector comprises:

10   a level candidate calculator for calculating a level candidate of the non-zero DCT coefficient based on the target code length and a zero-run length of the non-zero DCT coefficient;

a determiner for determining whether a corrected
15   code length of a code generated from a combination of the zero-run length and the level candidate of the non-zero DCT coefficient substantially matches the target code length; and

a corrector for correcting a level of the non-zero DCT coefficient to the level candidate when the corrected
20   code length matches the target code length.

6.   The system according to claim 5, wherein the level candidate calculator comprises:

a candidate generator for generating a level
candidate based on the target code length and a zero-run length
of the non-zero DCT coefficient;

a level range limiter for limiting a level range

5   of the non-zero DCT coefficient, wherein the level range is
limited by a maximum level and a minimum level; and

a level selector for selecting one of the level
candidate, the maximum level and the minimum level depending
on whether the level candidate falls within the level range.

10   7.   A method for inserting additional information in
DCT (discrete cosine transform) coefficients by referring to
a variable-length code table, wherein the DCT coefficients are
generated in blocks from image data, the method comprising the
steps of:

15   a) inserting additional information into input DCT
coefficients in a block by changing at least one DCT coefficient
of the input DCT coefficients to produce changed DCT
coefficients; and

b) correcting a level of one DCT coefficient

20   selected from the changed DCT coefficients in the block to
produce corrected DCT coefficients by referring to the
variable-length code table, wherein the one DCT coefficient is
selected so that a total code length of codes generated from
the corrected DCT coefficients is equal to an original total

code length of codes generated from the input DCT coefficients
in the block.

8.   The method according to claim 7, wherein the step
(b) comprises the steps of:

5   b.1) calculating a total code length difference
between the original total code length and a total code length
of codes generated from the changed DCT coefficients in the
block;

               b.2) calculating a target code length for a
10   non-zero DCT coefficient sequentially selected from the changed
DCT coefficients based on a difference between the total code
length difference and a current code length of the non-zero DCT
coefficient; and

               b.3) correcting a level of the non-zero DCT
15   coefficient to produce corrected DCT coefficients when a
corrected code length of a code generated from a combination
of a zero-run length and a corrected level of the non-zero DCT
coefficient substantially matches the target code length.

9.   The method according to claim 8, wherein the step
20   (b.3) comprises the steps of:

               b.3.1) calculating a level candidate of the
non-zero DCT coefficient based on a current level of the non-zero
DCT coefficient;

b.3.2) determining whether a corrected code length of a code generated from a combination of a zero-run length and the level candidate of the non-zero DCT coefficient substantially matches the target code length; and

5   b.3.3) correcting a level of the non-zero DCT coefficient to the level candidate when the corrected code length matches the target code length.

10.   The method according to claim 9, wherein the step (b.3.1) comprises:

10   a level range limiter for limiting a level range of the non-zero DCT coefficient based on the current level of the non-zero DCT coefficient; and

                    a candidate generator for generating a level candidate within the level range.

15   11.   The method according to claim 8, wherein the step (b.3) comprises the steps of:

                    b.3.1) calculating a level candidate of the non-zero DCT coefficient based on the target code length and a zero-run length of the non-zero DCT coefficient;

20   b.3.2) determining whether a corrected code length of a code generated from a combination of the zero-run length and the level candidate of the non-zero DCT coefficient substantially matches the target code length; and

b.3.3) correcting a level of the non-zero DCT coefficient to the level candidate when the corrected code length matches the target code length.

12.   The method according to claim 11, wherein the step
5   (b.3.1) comprises the steps of:

generating a level candidate based on the target code length and a zero-run length of the non-zero DCT coefficient;

limiting a level range of the non-zero DCT
10   coefficient, wherein the level range is limited by a maximum level and a minimum level; and

selecting one of the level candidate, the maximum level and the minimum level depending on whether the level candidate falls within the level range.

15   13.   A recording medium storing a computer-readable program for inserting additional information in DCT (discrete cosine transform) coefficients by referring to a variable-length code table, wherein the DCT coefficients are generated in blocks from image data, the program comprising the steps of:
20   a) inserting additional information into input DCT coefficients in a block by changing at least one DCT coefficient of the input DCT coefficients to produce changed DCT coefficients; and

b) correcting a level of one DCT coefficient selected from the changed DCT coefficients in the block to produce corrected DCT coefficients by referring to the variable-length code table, wherein the one DCT coefficient is

5   selected so that a total code length of codes generated from the corrected DCT coefficients is equal to an original total code length of codes generated from the input DCT coefficients in the block.